THE CRUSHED STONE JOURNAL

Official Publication
The National Crushed Stone Association

In This Issue—

Relation Between Durability of Concrete and Durability of Aggregates

Limestone Screenings Improve Concrete Products

Cement Bound Roads

Meet Me at the Hotel Jefferson

DECEMBER, 1930

WHY HAVE LOSSES

Poor Grading—High Overhead—Troubles

Ask the following stone producers why they are using NIAGARA ROLLER BEARING SCREENS year after year

Solvay Process Company	Jamesville, N. Y.
Solvay Process Company	Syracuse, N. Y.
Rock-Cut Stone Company	Auburn, N. Y.
Rock-Cut Stone Company	Ballina, Madison Co., N. Y.
Rock-Cut Stone Company	Jamesville, N. Y.
Rock-Cut Stone Company	Lacona, N. Y.
Rock-Cut Stone Company	Watertown, N. Y.
Mohawk Limestone Products Company	Mohawk, N. Y.
Mohawk Limestone Products Company	Jordanville, N. Y.
Mohawk Limestone Products Company	Mount Vision, N. Y.
BUFFALO Crushed Stone Company	Buffalo, N. Y.
Federal Crushed Stone Company	Cheektowaga, N. Y.
Genesee Stone Products Company	Stafford, N. Y.
LeRoy Lime and Crushed Stone Company	LeRoy, N. Y.
Ribstone Concrete Products	LeRoy, N. Y.
Dolomite Products Company	Rochester, N. Y.
General Crushed Stone Company	Oaks Corners, N. Y.
General Crushed Stone Company	North LeRoy, N. Y.
General Crushed Stone Company	Glenmills, Penna.
Wagner Quarries	Sandusky, Ohio
Wagner Quarries	Castalia, Ohio
Dolomite, Inc.	Maple Grove, Ohio
Herzog and Sons	Forest, Ohio
Ohio Blue Limestone	Marion, Ohio
National Lime & Stone Co.	Spore, Ohio
National Lime & Stone Co.	Carey, Ohio
National Lime & Stone Co.	Lewisburg, Ohio
National Lime & Stone Co.	Bluffton, Ohio
Belle Center Stone Co.	Belle Center, Ohio
Higgins Stone Company	Bellevue, Ohio
Lake Erie Limestone Company	Youngstown, Ohio
Lake Erie Limestone Company	Lowellville, Ohio
Lake Erie Limestone Company	Hillsville, Pa.
Lima Stone Company	Lima, Ohio
Spencer Stone Company	Spencerville, Ohio
Union Limestone Company	Youngstown, Ohio
Ohio Marble Company	Piqua, Ohio
C. C. Beam	Melvin, Ohio
Rock Products Company	Toledo, Ohio
France Stone Company	Holland, Ohio
France Stone Company	Monroe, Mich.
Swint Stone Company	Fremont, Ohio
J. E. Baker Company	Bainbridge, Lancaster Co., Pa.
J. E. Baker Company	White Hall, Baltimore, Md.
New Castle Lime & Stone Company	New Castle, Pa.
New Castle Lime & Stone Company	Dunbar, Pa.
Lehigh Stone Company	Ormrod, Pa.
Stowe Trap Rock Company	Pottstown, Pa.
Carbon Limestone Company	Hillsville, Pa.
Blue Stone Quarry Company	Gwynedd Valley, Pa.
Whiterock Quarries	Pleasant Gap, Pa.
Connecticut Quarries Company	Rocky Hill, Conn.
New Haven Trap Rock Company	New Haven, Conn.
Edward Balf Company	Hartford, Conn.
John S. Lane and Son	Westfield, Mass.
West Roxbury Trap Rock Company	West Roxbury, Mass.
Old Colonial Crushed Stone Company	Quincy, Mass.
Rowe Contracting Company	Malden, Mass.
Simbrico Stone Company	West Roxbury, Mass.
Casper Stolle Quarry & Construction Co.	East St. Louis, Ill.
Consumers Company	Lemont, Ill.
Federal Stone Company	LaGrange, Ill.
Michigan Limestone & Chemical Company	Rogers City, Michigan
Blesans Stone Company	Winona, Minn.
Meshberger Bros. Stone Company	Berne, Ind.
Hy-Rock Products Company	Marengo, Ind.
Fanwood Stone Crushing & Quarry Co.	Fanwood, N. J.
Samuel Braen	Patterson, N. J.
Orange Quarry Company	West Orange, N. J.
Granite Rock Company	Logan, Calif.
Daniel Contracting Company	San Francisco, Calif.
Deitz Hill Development Company	Kansas City, Mo.
Rock Hill Quarries Company	St. Louis, Mo.
Texas Trap Rock Company	San Antonio, Texas
Dittlinger Lime Company	New Braunfels, Texas
James Stone Company	Corsicana, Texas
Franklin Limestone Company	Nashville, Tenn.
Gager Lime Company	Sherwood, Tenn.
John H. Wilson	Honolulu, Hawaii

CANADA

J. A. Bourbonnais	Vaudreuil, Que.
Canada Crushed Stone Corp.	Puslinch, Ont.
Coast Quarries	Vancouver, B. C.
Dufferin Construction Company	Innerkip, Ont.
Gordon Crushed Stone Company	Hagersville, Ont.
Thomas Langton Crushed Stone	Coldwater, Ont.
LaCle A. Desrosiers, Ltd.	Montreal, Que.
Puslinch Quarries, Ltd.	Puslinch, Ont.
Quinn Stone and Ore Company	Ft. William, Ont.
Rigand Granite Products Company	Rigand, Que.
Stone and Son	Ingersoll, Ont.
Standard Lime Company, Ltd.	Joliette, Que.
Walker Bros.	Thorold, Ont.
Warden King Company, Ltd.	Montreal, Que.

LET US FIGURE YOUR PROBLEMS

NIAGARA CONCRETE MIXER CO.

40 PEARL STREET

BUFFALO, N. Y.

ROL-MAN for Low-Cost Operation



IN THE plant in which the above picture was taken, Universal Vibrators equipped with ROL-MAN Screen Cloth have handled more than 1,000,000 tons of crushed stone before replacement of the screen cloth was necessary. Truly this is low-cost operation, together with freedom from interruptions to service.

Such economy is only possible because ROL-MAN Screen Cloth is manufactured of a true manganese steel which has the greatest resistance to abrasive wear of any alloy steel made. Its exceptional toughness and strength are also important factors in the long life for which this screen cloth has become noted.

The patented double-lock mesh weave used exclusively in the manufacture of ROL-MAN Screen Cloth insures accurate sizing of the product throughout the life of the cloth. Bulletin No. 120 will be sent to you on request. It contains 48 pages of valuable data on the application and operation of vibrating, revolving, shaking and inclined-gravity screens.

The Universal Vibrating Screen Co. and other manufacturers of screening equipment will supply ROL-MAN, if specified, on new machines, or will supply it for replacements on existing machines. Ask for ROL-MAN by name to be sure of obtaining the high efficiency and long life for which these true manganese-steel screens are noted. There will be no delay—shipments are made promptly.

ROL-MAN
A TRUE MANGANESE STEEL

MANGANESE STEEL FORGE COMPANY
Manufacturers of
ROL-MAN ROLLED AND FORGED MANGANESE-STEEL PRODUCTS
Richmond Street and Castor Avenue, Philadelphia, Pa.

the READY MIXED CONCRETE INDUSTRY *is hitched to a star*

The success of the 71 companies named below, points significantly to the value of Blaw-Knox Service. These firms form the backbone of the Ready Mixed Concrete Industry. They operate over 100 Blaw-Knox Ready Mixed Concrete Plants for producing and placing on the job vast quantities of highest quality concrete.

BLAW KNOX



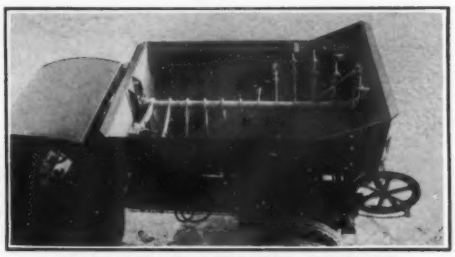
A Partial List of Ready Mixed Concrete Plants designed and built by Blaw-Knox

Abel Construction Co., Lincoln, Nebraska.
Aluminum Company of America. Alcoa, Tenn.
Atlas Sand, Gravel & Stone Co., Hartford, Connecticut.
Avril Tru-Batch Concrete Co., Cincinnati, Ohio.
Arrow Sand & Gravel Co., Columbus, Ohio.
The Builder's Supply Co., Akron, Ohio.
Edw. Balf Company, Newington, Connecticut
Baker & Holmes Jacksonville, Fla.
Belmont Gurnee Stone Co., N. Bergen, N. J.
Billiter, Miller & McClure, Covington, Kentucky.
Birmingham Slag Company, Birmingham, Ala.
Boston Sand & Gravel Co., Cambridge, Mass.
Samuel Braen's Sons, Hawthorne, N. J.
Geo. M. Brewster Co., Bogota, N. J.
Bridges Asphalt Paving Co., St. Louis, Mo.
Builders Supply Co., Akron, Ohio.
Corson & Gruman, Washington, D. C.
Caldwell Construction Co., Charlotte, N. C.
Cincinnati Builders & Sup. Co., Cincinnati, Ohio.
J. P. Callahan, Inc., Harrison, N. J.
Camden Lime Co., Camden, N. J.
Central Concrete Engr. Co., Jacksonville, Fla.
Central Concrete Mixing Corp., Brookiyn, N. Y.
Dufferin Paving Company Toronto, Ontario, Canada.
Elizabeth Sash, Door & Sup. Co., Elizabeth, N. J.
Espy Paving & Constr. Co. Savannah, Georgia.
Feldman & Golatz, Allentown, Pa.
Fitzgerald Construction Co., Ashtabula, Ohio.
General Electric Company, Schenectady, N. Y.
General Materials Co., St. Louis, Mo.
Guaranteed Concrete Co., St. Paul, Minn.
Hodgson-Jones Constr. Co., Montgomery, Ala.
John L. Humbard Constr. Co., Knoxville, Tennessee.
Jahncke Service, Inc., New Orleans, La.
Keystone Constr. Co., Meadville, Pa.
Kolinski Ready Mixed Concrete Co., Milwaukee, Wisconsin.
P. W. Lambert & Co., Linden, New Jersey
Geo. Lanz & Sons, Pittsburgh, Pa.
Liberty Corp. Philadelphia, Pa.
MacDougald Constr. Co., Atlanta, Georgia.
McCrady-Rodgers Co. Pittsburgh, Pa.
Morgan Sand & Gravel Co., Brooklyn, N. Y.
Metropolitan Concrete Co., Cleveland, Ohio.
Maloney Paving Co., Washington, D. C.
Patrick McGovern, Inc., New York, N. Y.
Morris Co. Crushed Stone Co., Morristown, N. J.
Bureau of Supplies & Accounts, Navy Department Puget Sound, Washington
Northern States Constr. Co., St. Paul, Minn.
Northport Sand & Gravel Co., Northport, L. I., N. Y.
New York Power Corp. Potsdam, N. Y.
J. & I. O'Rourke, Flushing, L. I., N. Y.
Ready Mixed Concrete Co., Omaha, Nebraska.
Ready Mixed Concrete, Ltd., Montreal, Quebec, Canada.
Ready Mixed Concrete Co., Rome, Georgia.
Ruth Lumber & Supply Co. Scottdale, Pa.
N. Ryan Company, Inc., Brooklyn, N. Y.
Stires Bros. Constr. Co., St. Louis, Mo.
Scranton Ready Mixed Concrete Co., Scranton, Pa.
Super Concrete Corp., Washington, D. C.
The Ready Mixed Concrete Co., Pittsburgh, Pa.
Transit Mix Concrete Corp. New York, N. Y.
Transit Mix Concrete Co., Morris Plains, N. J.
Tucker Concrete Material Co. Fort Worth, Texas.
Thompson Brothers, Fresno, California.
Union Paving Company, Philadelphia, Pa.
Union Building & Contracting Co., Passaic, N. J.
Abram Vandermade, Paterson, N. J.
Ed. Vero, Millvale, Pa.
Warner Company, Philadelphia, Pa.
Woodstock Sash Slag Corp., Birmingham, Ala.
York Concrete Co., York, Pa

READY MIXED CONCRETE PLANTS

BLAW-KNOX

Blaw-Knox Agitator Truck Bodies prevent segregation of aggregates and improve the mix during the haul.



AGITATOR TRUCK BODIES

BLAW-KNOX COMPANY

2053 Farmers Bank Building — Pittsburgh, Pa.

Send complete information and literature about:

Blaw-Knox Ready Mixed Concrete Plants ☐

AGITATOR Truck Bodies ☐

Company_____

Individual_____

Street_____

City_____ State_____

The CRUSHED STONE JOURNAL

Published by The National Crushed Stone Association

Merchandise Building, 14th and S Sts., Washington, D. C.

Vol. VI No. 12 WASHINGTON, D. C. *December, 1930*

Relation Between Durability of Concrete and Durability of Aggregates[1]

Prepared for the Committee on Aggregates, Highway Research Board

By F. H. JACKSON,

U. S. Bureau of Public Roads

Introduction

This report will consist of two parts:

1. A short general discussion of durability of concrete, with special reference to the relation of aggregates to durability, and including certain suggested outlines of research along lines commented upon in the discussion.

2. A bibliography of literature upon the subject.

Discussion

During the course of the Symposium on Mineral Aggregates held during the 1929 meeting of the American Society for Testing Materials, many of the authors stressed the importance of knowing more about the effect of quality of aggregates upon the durability of concrete. Information concerning this essential property of concrete is of special importance to the highway engineer because of the severe weathering conditions to which concrete employed in highway construction must of necessity be exposed. Knowledge of the strength characteristics of concrete becomes to him therefore of secondary importance to a knowledge of methods of securing durability. In spite of this, almost all of the research data regarding concrete which have been made available in the past deal with strength rather than durability. However, this is a natural development, due to the fact that the first investigations in concrete were in connection with its use in building construction, where the material is in general protected from the weather and strength becomes, therefore, the essential characteristic. With the expanding use of concrete into many fields which involve exposure to the action of the elements, such as pavements, bridges, dams, stadiums, retaining walls, etc., has come the realization that designing for strength in accordance with the old accepted methods does not necessarily insure durability. This truth has been brought home many times during recent years by reason of the weathering of many exposed structures in which the concrete, measured by the conventional yardstick, strength, met every requirement.

The writer has been assigned the task of preparing an outline of research on the problem "Relation Between Durability of Concrete and Durability of Aggregates." It will be necessary before proceeding to the preparation of such an outline to consider briefly the general question of "durability" in concrete, the conditions which affect it and the means which may be used to insure it. The word "durability" in this discussion will be assumed to mean the ability to resist insofar as possible the destructive effects of water, ice and temperature change as they would normally occur and does not include resistance to such destructive agencies as strong alkali or acid waters, sea water, etc. Of course when we speak of durability or resistance to weathering in concrete we speak in relative terms, just as we would speak of durability in any other structural material. No material is permanent in the sense that it will resist for all time the external forces of weathering. All that we can hope to do with concrete is to so select the constituent materials and so control the manufacturing processes that the product will be as nearly resistant to the natural

[1] Presented at the Tenth Annual Meeting of the Highway Research Board, December 11 and 12, 1930.

forces of disintegration as our present knowledge makes possible.

The function of the aggregate in contributing to the above end is the subject with which we are primarily concerned. The aggregate is, however, only one of a number of factors which influence durability. Moreover, the behavior of an aggregate in concrete may be quite markedly affected by these other variables so that a study of the aggregate factor in reality involves a study of all of the variables, including both materials and methods of manufacture, which may contribute to durability or the lack of it.

In all discussions of durability of concrete the role of water as a destructive agent has been greatly emphasized. All authorities agree that, if corrosion or weathering is to be minimized, water must be excluded, although they do not always agree as to the exact nature of the chemical or physical action which takes place during weathering. For instance, it has been commonly asssumed that most of the examples of concrete disintegration, especially those in the northern states, are due to alternate freezing and thawing. The action in such cases is of course purely mechanical, and is due to the formation of ice crystals within the pore spaces of the concrete, the resulting expansive forces eventually producing disruption. Attention has recently been called, however, to the possibility that such effects may in many cases be due to the deposition of crystals of chemical salts within the pore spaces of the concrete rather than to ice crystals. Anderegg[1] has noted the possibility that even normal ground water may carry enough acid in solution to react with the constituents of the cement forming crystal compounds and that the growth of these crystals within the hardened concrete may easily produce the effects noted. It is not the purpose to go into the matter in any detail in this discussion. It must be apparent, however, that, irrespective of whether the action is chemical or physical or a combination of the two, water is the root of the trouble. The production of concrete which has the greatest possible resistance to the entrance of water (impermeability) should be the goal of every engineer and construction foreman charged with the duty of producing weatherproof concrete. The selection of the proper aggregates is only one of a number of steps which must be followed to this end. Moreover, the aggregates play a double role in the production of durable concrete. They must not only be composed of sound and durable particles (which may be termed a fundamental requirement) but these particles must be so graded in size as to produce concrete of plastic and workable consistency with the least amount of water in proportion to the amount of cement required. It seems at times that possibly too much emphasis is placed on the character of the aggregate and not enough on the proper design of the mixture and the placing of the concrete. The condition surveys which have been conducted by the Committee on Destructive Agencies of the American Concrete Institute[2] have indicated that the vast majority of failures through disintegration are due primarily to failure to produce concrete which is uniformly impermeable to water and that in only a relatively small number of cases can the trouble be traced definitely to lack of durability in the aggregates. This may be due to the fact that aggregates from established commercial sources of supply are employed in the great bulk of the total yardage of concrete placed in this country. However, economic considerations dictate that, wherever feasible, local aggregate supplies be considered and it is in such cases that definite assurance must be had of the durability of the aggregate to be used. There are, moreover, a sufficient number of cases on record where failure can definitely be traced to the character of the aggregate to warrant a thorough investigation of durability from this standpoint.

What are the inherent characteristics of aggregates which affect their durability in concrete? How is the resistance of an aggregate to destructive agencies affected by the other characteristics of the concrete such as permeability, water absorption, etc.? To what extent may it be possible to protect a doubtful aggregate with a cement paste of high quality? Is it possible to develop laboratory tests for durability of concrete which will simulate actual weathering in the field?

The above are just a few of the questions which come to mind when discussing this subject. They must be answered before any real progress can be made in solving the problem. Isolated attempts have been made by independent investigators to throw light on specific phases of the problem which have resulted in the accumulation of a mass of unrelated data which can not be correlated and which for this reason is of doubtful value. The bibliography attached to this report illustrates the point. The need is for an agency which can direct and coordinate an adequate

[1] Proc. American Concrete Institute 1929, page 332.

[2] Journal A. C. I., Vol. 1, page 41; Proc. A. C. I., 1929, p. 27; Proc. A. C. I., 1926, p. 64.

investigation of the problem both in the laboratory and in the field in such a manner that the results secured by each investigator can be correlated with those obtained by others and sound, authorative conclusions drawn from the whole. The Highway Research Board is the logical agency to direct such an investigation, due to the prime importance of durability as an essential characteristic of concrete used in highway construction.

Method of Attacking the Problem

It would seem necessary to attack the problem from both the field and laboratory standpoint. A field survey of existing structures, the history of which is known, is absolutely essential before the results of laboratory tests and investigations on either the concrete or the aggregates can be interpreted. By the same token, laboratory tests under controlled conditions are equally necessary in order to verify field indications. Laboratory investigations are necessary also in order that suitable tests for durability may be developed. It is obvious that a coordinated laboratory study of durability can not be under-taken until a test or tests for durability have been standardized.

Any test for durability which may be made upon an aggregate, as for instance, the sodium sulphate soundness test, is only of value insofar as it is possible to correlate it with the behavior of the concrete in which the aggregate is used. It is the durability of the concrete in which we are interested and for this reason it would seem logical that tests for durability, especially those of a research nature, should be conducted upon the concrete rather than upon the aggregate. This is especially important when it is realized that the behavior of an aggregate in concrete may be influenced by other variables, such as water-ratio, cement content, etc. In other words, it may very well be possible that an aggregate which is unsatisfactory when used in a lean concrete having a high water ratio may prove satisfactory in a rich concrete protected by a cement paste of high quality.

On the other hand, the quality of the aggregate may not be the critical factor when a high water-cement ratio is used, failure in this case being due to the poor quality of paste which would cause disintegration regardless of the quality of the aggregate used.

What are the most significant tests by which we may measure durability? In the first place it is recognized that frost action is undoubtedly a factor in the weathering of concrete. For this reason, most investigators of weathering have utilized the freezing test in an effort to simulate such action in nature. No effort has been made as yet, however, to standardize a freezing and thawing test of concrete. In working out a program of research along this line we are faced with a number of questions which must be answered as, for instance, how are the results affected by variations in:

(1) The size and shape of the test specimens.

(2) The nature of the surface exposed to frost action; as for instance, a surface molded against a form, a surface finished by means of a strike-off, trowel, etc., and a sawed surface which exposes the aggregate.

(3) Method of insuring saturation of the specimen at time of freezing; that is, should the specimen be frozen (a) wholly in water, (b) partially immersed, or (c) saturated and then frozen in air.

(4) Minimum temperature at which freezing should take place.

(5) Rate of freezing, including (a) time required to reach minimum temperature and (b) time held at minimum temperature.

(6) Method of evaluating specimens after test; i. e., by (a) visual examination, or (b) strength tests compared to strength of corresponding specimens stored under normal conditions.

The following outline of research is suggested as the basis for an investigation of methods of establishing a standard test procedure:

A. Equipment:
In addition to the usual equipment for conducting tests of concrete, either a room or compartment in which freezing tests can be conducted will be necessary. Such a compartment should be designed so that not only minimum temperatures but rate of drop in temperature can be controlled.

B. Materials:
Single standard brand of Portland cement.
Concrete sand of known satisfactory quality.
Crushed stone of known durability.
Crushed stone of known unsatisfactory quality from the standpoint of durability.

C. Procedure:
Variables to be studied:
(1) Size and shape of specimen.
(a) Six inch by 12 inch cylinders.
(b) Six inch cubes (molded).

(c) Six inch cubes sawed from 6 inch by 6 inch by 30 inch beams.

(2) Character of surface of specimen.
(a) To be investigated by observing relative action on sawed cubes (1 (c)).

(3) Saturation of specimen.
(a) Wholly in water. Specimens to be placed in thin metal containers of slightly larger capacity than the specimens and the containers filled with water. Frozen in this condition.
(b) Partly in water. Specimens to be saturated, then placed in pans and supported on racks in such a manner that approximately one inch of concrete only is immersed in water. Frozen in this condition.
(c) In air. Specimens to be thoroughly saturated and then immediately removed to freezing compartment and to be frozen in air.

(4) Minimum temperatures.
Specimens to be frozen at 20° F., 10° F., and 0° F.

(5) Rate of freezing.
Specimens to be frozen rapidly, so that the minimum temperature is reached in approximately one hour after start of tests and slowly so that the minimum temperature is reached in about ..... hours after start of test.
Specimen to be (1) removed immediately after reading minimum temperature and (2) held at minimum temperature for ..... hours.

(6) Thawing temperatures.
Specimens to be thawed at 70° F.

Each of the above variables should be investigated with at least five classes of concrete, as follows:

Class	(1)	Water-cement	ratio	.....	0.6
"	(2)	"	"	.....	0.7
"	(3)	"	"	.....	0.8
"	(4)	"	"	.....	0.9
"	(5)	"	"	.....	1.0

as well as with two combinations of aggregates, as follows:

Combination A. Above cement and sand with coarse aggregate of known durability.

Combination B. Above cement and sand with coarse aggregate of known unsatisfactory quality.

The above outline is offered merely as an illustration of the character and amount of work involved in a study of this kind. It is obvious that it would require a laboratory having somewhat unusual facilities as regards both equipment and funds to undertake a complete program of research along this line. It is possible that the work might be divided among several laboratories, each being assigned a specific phase of the problem. In any event an investigation of the technique of the freezing test should be undertaken and further information obtained as to the effect of variations in procedure before carrying out a general investigation of durability.

Assuming that a freezing test is a true indication of durability and that a standard method has been agreed upon, we are in a position to investigate durability in the laboratory. This phase of the study should be carried on in conjunction with field study of aggregates. Tests should be made on concrete containing aggregates of various types and carrying various percentages of presumably deleterious substances and the relative behavior of the concrete noted. In connection with each aggregate investigated tests should be made on concrete of various water-cement ratios ranging from, say 0.5 to 1.0, in order to determine effect of richness of mix as related to kind of aggregate. The results obtained should be correlated with the quantity of such materials in the aggregate as chert, shale, clay seams, etc., in crushed stone, shale, chert, soft or rotten particles in gravel, shale in sand, etc. A thorough study along these lines should furnish data which would enable the specification writer to set more definite test limits for deleterious substances in aggregates than is now possible.

Field Survey

The writer feels that a systematic and thorough field study of concrete in use, from the standpoint especially of aggregates employed, would be highly desirable. Such a survey should be carried out by an entirely disinterested agency such as the Highway Research Board. A competent investigator should be appointed who could give full time to the work and who might function under the general direction of the

Committee on Aggregates in a manner similar to the procedure followed in the study of methods of curing concrete pavements recently conducted by the Board. It would be the duty of such an investigator to make a detailed study of existing concrete structures in which questionable aggregates have been employed, procuring in each case as complete a history as possible regarding the exact materials used, methods of construction and other details. A study of this nature should develop valuable indications as to effect of aggregates upon service behavior which could be correlated with the laboratory investigations previously discussed.

Thermal Expansion

The possibility that there may be enough difference in the thermal coefficient of expansion of certain types of aggregate as compared to the concrete in which they are used to develop internal strains of sufficient magnitude to cause failure, has been advanced.

A series of thermal expansion tests should be conducted on concrete for the purpose of determining what weakening effect, if any, may result from the use of such materials as flint, etc. Paralleling this work, tests should be made to determine the thermal coefficients of expansion of the aggregates themselves. Such tests might be made on 1-inch cores drilled from the material to be tested, and the determination made by means of a small linear comparator, on specimens of approximately 4 inches in length. There is a possibility that interesting developments might result from a study of this kind. The effect upon the concrete might be determined by subjecting concrete specimens, say 6-inch by 12-inch cylinders, to a number of alternations in temperature (maximum range about 100° F.) and comparing the strength with similar specimens stored under the same conditions except that a constant temperature is maintained. It would be interesting to investigate in this connection the effect of size of aggregate, on the theory that the total internal pressure developed at any point would be in proportion to the size of the individual fragments of aggregate. In other words, it might develop that an aggregate which would prove dangerous when used in fragments up to, say 3 inches in diameter, would be entirely satisfactory were the maximum size limited to ¾-inch.

Sodium Sulphate Test

In connection with this test the writer is giving below the text of a statement prepared by Messrs. A. T. Goldbeck, Stanton Walker, H. J. Love and Fred Hubbard, acting on behalf of the three aggregate associations, and prepared in connection with a discussion of recently proposed revisions in federal specifications for aggregates.

The following are some of the difficulties experienced with the test procedure as outlined in U. S. D. A. Bulletin 1216, page 20, 1928, revision:

(a) Sample too small.
(b) Sample source not definite.
(c) Test seems to apply to rock only and not to gravel and slag.
(d) Has no adaptation for fine aggregates.
(e) Gives no specific number of cycles.
(f) Gives no means for accurately interpreting the test results in terms of failure or acceptance, since "marked disintegration" may mean anything or nothing.
(g) The test procedure states nothing about temperature of the immersing solution, which is a very important factor.
(h) The temperature of saturation (70° F.) is too low to avoid undersaturation much of the time.

Because of the serious objections to the present test procedure, of which the one outlined in U. S. D. A. Bulletin 1216, page 20, 1928 revision, is the most widely accepted, the following procedure is suggested, which is free from many of the inaccuracies previously encountered. This procedure is worthy of consideration for five reasons:

1. It makes more definite the source and selection of samples and increases the sample to a more satisfactory size.
2. It is adaptable to all types of coarse and fine aggregates.
3. A definite control of temperature of saturation and of maintaining the solution throughout the test is stipulated, which guards against test inaccuracies.
4. A quantitative means of measuring distress during the soundness test is given so that results may be comparable and have meaning.
5. Definitions of "failing," "doubtful" and "acceptable" material are given.

Sodium Sulphate Soundness Test

Samples

Source. In conducting the test the sample shall be taken whenever possible from material prepared for commercial use. Every care shall be taken to make

the sample truly representative of the material to be used.

Size. If the material is to be used for concrete coarse aggregate the sample shall consist of at least fifty (50) pieces between 2 in. and 1 in., square opening sieve, (and) or of 2500 grams of material between 1 in. and ½ in. If the material is to be used for concrete fine aggregate the sample shall consist of 1000 grams carefully screened between any desired sieves, such as 4-8, 8-14, or 14-28 mesh, etc.

Selection. All samples shall be secured by quartering or dividing to the desired numbers or amounts, thus eliminating as much as possible the personal element from the selection of the samples.

Solution

The solution of sodium sulphate shall be prepared in the following manner:

Anhydrous sodium sulphate (Na_2SO_4) or the decahydrate ($Na_2SO_4.10H20$) shall be added to hot water at the rate of 400 grams or 900 grams per liter, respectively, or in round numbers, .9 lb. or 2 lb. per quart of water. The solution shall be heated one-half hour to 85-90 degrees F. with frequent stirring to prevent caking in the bottom and to effect solution quickly. After this it shall be set aside for at least 12 hours before use. During the preparation and use of this solution there should be present at all times excess crystals of the salt (decahydrate) to insure saturation. The solution may be conveniently kept in a large earthenware covered crock when not in use. Suitable receptacles for the individual sample solutions are one gallon earthenware crocks. The fine aggregate samples should be contained in fine mesh wire baskets which can be lowered into the solution contained in one-half gallon crocks. These may be covered easily, have poor thermal conductivity, are not attacked by the solution and are readily cleaned.

Test Procedure

Immersion. The selected sample shall be examined for fractures and cracked pieces, any loose fragments being removed before the test is begun. The sample is then plainly marked and thoroughly dried for at least four (4) hours at 212 to 225 degrees F., carefully weighed and then completely immersed in the solution. The soaking period shall continue for nineteen (19) hours with the temperature of the solution maintained between 80 and 85 degrees F.

Examination. At the end of each soaking period the specimen (of the larger sizes) shall be examined individually, with great care, for any sign of disintegration, such as cracking, checking, splitting, crumbling, etc. The portions which can be removed with the fingers shall be taken off, weighed, set aside for later consideration and calculated to per cent loss for that cycle. A sample breaking into three or more pieces shall be considered as failing and shall be removed from the test, weighed and considered lost. The number of pieces affected during the cycle shall also be noted. Smaller aggregates and sands shall be examined visually after each cycle for apparent distress. After each five cycles the samples shall be dried, sieved and the per cent of material determined which now passes the lower size sieve.

Drying. After examination the specimen shall be placed in a previously heated drying oven and be maintained for four (4) hours at a temperature of 212 to 225 degrees F. Then the sample shall be cooled for one (1) hour before being immersed in the sodium sulphate solution. One cycle shall consist of four (4) hours drying, one (1) hour cooling, nineteen (19) hours soaking, and an examination of the material. The test shall be run for five (5) cycles on concrete aggregates.

Interpretation of Test

An individual specimen breaking into three or more portions (each portion being more than 10 per cent of the original weight of the piece) or losing more than 20 per cent of its weight by chipping or flaking shall be considered to have failed in the test. A sample having 20 per cent or more of its pieces failing shall be considered unsound. Likewise, when 20 per cent or more by weight of chips and flakes are formed during the test passing the ½ in. screen (square openings) this shall constitute unsoundness in the sample. A sample shall be classed as of "doubtful soundness" when 15-20 per cent of its pieces fail or if 15-20 per cent of its weight is lost in chips and fragments. Such material shall be tested again for durability. If it is classed as "doubtful" the second time this behavior shall be construed to indicate the unsoundness of the sample.

Materials for smaller aggregates and sands shall be classed as unsound when more than 20 per cent by weight is reduced in size during the test to pass the original sample's lower sieve limit. At the end of the test the remaining portion of the sample shall be freed from Na_2SO_4 by a repeated boiling and soaking process, the wash water being renewed four or five times. After drying and weighing the total loss during the

test is determined by the difference between the original and the final weights of the sample.

Materials not falling in the above classification shall be considered sound.

Materials failing shall not be used unless their durability has been demonstrated by service behavior.

A considerable amount of work has been done recently along the line of soundness investigations by the Sanitary Committee of the A. S. C. E. The above recommendations are based quite largely on these investigations and on work along the same line which has been carried on by members of the National Crushed Stone Association.

There seems no question but that the method of conducting the sodium sulphate test as now specified in Bulletin 1216 is inadequate because of failure to specify the test procedure in sufficient detail. Investigations should be conducted with the view to standardizing procedure. The proposed method would form an excellent starting point.

The sodium sulphate test has also been of limited value due to lack of information as to the relation between the effects observed in the test and results in service. Until more information can be secured along this line it will be necessary to use the test simply as an indication of possible unsoundness and not as a definite specification requirement.

Summary

In conclusion the writer believes that the problem of determining the relation between durability of concrete and durability of aggregates may be logically divided into two parts, as follows:

A. Laboratory studies leading to the standardization of tests for durability of

1. Aggregates as such:
   - (a) Immersion in sodium sulphate, etc.
   - (b) Freezing and thawing.
2. Aggregates in concrete (concrete tests).
   - (a) Freezing and thawing.
   - (b) Thermal expansion.

B. Laboratory and field investigations of aggregates for the purpose of correlating results of tests with service behavior with the ultimate object of establishing definite limits for various constituents of aggregates which lack durability.

1. Laboratory studies.
   - (a) Effect of varying percentages of certain mineral constituents in sand, such as shale, feldspar, chert, etc., on durability of mortars and concrete, as follows:
     - (1) Sodium sulphate and freezing tests on the aggregates.
     - (2) Freezing and thawing tests on mortars containing the aggregates in mixes having a range in water ratio of from 0.5 to 0.9.

(The effect of shale, feldspar, etc., in sand should be investigated on samples taken from various localities and prepared so as to contain definite predetermined percentages of the material being investigated).

   - (b) Effect of chert in gravel or crushed stone on durability of concrete.
     - (1) Sodium sulphate and freezing tests on aggregates.
     - (2) Freezing tests on concrete containing the aggregate in mixes having a water-cement ratio of 0.6 to 1.0.
     - (3) Alternate heating and cooling of concrete specimens containing chert in predetermined quantities and of variable maximum size. Range in temperature to be about 100° F.

(This series should include tests on samples of deposits containing chert from various localities and should include studies on the concrete containing definite, predetermined percentages of chert as well as a complete petrographic study of the character of the chert in each case).

   - (c) Effect of shale in gravel on durability of concrete.
     - (1) Sodium sulphate and freezing tests on aggregates.
     - (2) Freezing tests on concrete containing the aggregate in mixes having a water-cement ratio of 0.6 to 1.0.
   - (d) Effect of shaley and argillaceous limestone on durability of concrete.
     - (1) Sodium sulphate and freezing tests on aggregates.
     - (2) Freezing tests on concrete containing the aggregate in mixes having a water-cement ratio of 0.6 to 1.0.

(*Continued on page* 22)

Limestone Screenings Improve Concrete Products[1]

By L. C. HILL

AUTHORITIES agree that the fineness modulus of an ideal sand or fine aggregate should be around 3.00, but there is a wide difference in opinion regarding the percentage of the aggregate, if any at all, that should pass the 100-mesh sieve.

The bulk of the sand on the market is a washed product and as naturally that very fine portion which ordinarily would pass the 100-mesh is washed out, probably the average percentage to pass the 100-mesh will not exceed 1%. It is claimed by some authorities that this fine material (that passing the 100-mesh sieve) causes crazing and excess shrinkage on setting. However, the author is in hopes that it will some day be proved, perhaps by means of slow-motion pictures, that crazing is caused by what might be termed a structural condition that exists during the setting process of the concrete.

Through several years of experimenting while the author was connected with the Jacksonville Concrete Products Co., Inc., of Jacksonville, Fla., he found that the pulverized limestone which was used in the manufacture of artificial stone had a peculiar effect in the block and tile mixes. It was found by a series of tests that substituting limestone for a portion of the sand lowered the absorption and increased the compressive strength. Between 5 and 10% of this limestone passed the 100-mesh sieve and undoubtedly this fine material united with the cement to form an abundance of paste which thoroughly coated each particle of the aggregate which in turn had a sort of a lubricating effect on the mix, producing a denser concrete having a higher compressive strength.

The above statement is verified in the Portland Cement Association booklet on "The Manufacture of Concrete Masonry Units," on page 4, which reads as follows: "In a recent series of tests on tamped concrete block, two varieties of fine aggregate containing relatively large percentages of dust finer than the 100-mesh sieve gave unexpectedly high strengths. Apparently a certain portion of very fine materials results in greater workability and increased strength."

Keen competition and building code requirements make it necessary to concentrate on the design of the mixes and secure the utmost in quality with a minimum of cost per batch. The question of mixing water is just as important in products work as it is in poured work; the tendency has always been to use too dry a mix, especially in making building units. It is an absolute fact that an increase of the compressive strength can be obtained by using the maximum of mixing water. The more mixing water you can get into the batch, up to the point where the units will

SOUTHERN TESTING LABORATORIES
Birmingham, Alabama
Report of Tests on Sample of Clay Tile and Concrete Block.
Laboratory Nos. J-5336 to 5344, inclusive.
Identification marks: See below.
Submitted by Jacksonville Concrete Products Co.
Reported to Jacksonville Concrete Products Co., Jacksonville, Fla.
Specifications governing: American Concrete Institute.

Lab. No.	Marks	Size	Area sq. in.	Weight lb.	Load lb.	Load lb./sq.in.	Absorption
J-5336	6-cell	8x12x12	96	35	27,860	290	20.7%
J-5337	6-cell	8x12x12	96	37.5	27,220	284	
J-5338	6-cell	8x12x12	96	36	38,260	399	
					Average,	324	
J-5339	H	7⅞x12x10⅛	90.75	....	71,200	785	9.0%
J-5340	H	7⅞x12x10⅛	90.75	....	70,300	775	
J-5341	H	7⅞x12x10⅛	90.75	....	61,620	679	
					Average,	746	
J-5342	Concrete	8x16x7¼	128	....	146,600	1145	6.5%
J-5343	Concrete	8x16x7¾	128	....	187,040	1461	
J-5344	Concrete	8x16x7½	128	....	†200,000	†1562*	
					Average,	1389+	

*Capacity of machine, 200,000 lb. †Above.

[1] Reprinted from November, 1930, issue of *Concrete Products*.

SOUTHERN TESTING LABORATORIES
Birmingham, Alabama
Report of Tests on Sample of Concrete Building Tile.
Laboratory Nos. J-6934-6939. Weight of sample, 50 lb.
Identification marks: Three marked "sand," three marked "limestone."
Made from special batches. Submitted by L. C. Hill, Jacksonville, Fla.
Specifications governing: American Concrete Institute.
NOTE—White sand from Diamond Sand Co., Interlachen, Fla. Gravel, ⅜-in. from Montgomery, Ala. Limestone from Brooksville, Fla. Cement, "Atlas" brand portland. Exactly 9 qt. water used to each bath. Moisture in sand and limestone not included.

Mark	Size, in.	Area sq. in.	Load, lb.	Load lb./sq.in.
Sand aggregate	7⅛x7⅛x15¾	123.95	132,600	1,069
Sand aggregate	7⅛x7⅛x15¾	123.95	138,180	1,114
Sand aggregate	7⅛x7⅛x15¾	123.95	127,080	1,025
			Average,	1,069
Limestone aggregate	7⅛x7⅛x15¾	123.95	144,440	1,164
Limestone aggregate	7⅛x7⅛x15¾	123.95	131,200	1,058
Limestone aggregate	7⅛x7⅛x15¾	123.95	150,460	1,213
			Average,	1,145

Absorption: Sand aggregate tile, 6.92%; limestone aggregate tile, 5.41%.

SCREEN ANALYSIS OF AGGREGATES FOR TEST BLOCKS

Screen	Gravel % on		Screen	Fine Limestone % on		Screen	Sand % on	
¾	0	.00	¾	0	.00	¾	0	.00
⅜	14	.14	⅜	0	.00	⅜	0	.00
4	79	.93	4	1	.01	4	0	.00
8	6	.99	8	19	.20	8	1	.01
14	1	1.00	14	22	.44	14	12	.13
28	0	1.00	28	25	.69	28	31	.44
48	0	1.00	48	20	.89	48	35	.79
100	0	1.00	100	8	.97	100	20	.99
		Thru 100		5	...	Thru 100	1	...
	100%	6.06 F.M.		100%	3.20 F.M.		100%	2.36 F.M.

COMBINED "A" MIX
(Sand and Gravel)

Screen	% on	
¾	0	.00
⅜	6	.06
4	27	.33
8	3	.36
14	8	.44
28	23	.67
48	24	.91
100	8.66	.9966
Thru 100	0.34	.....
	100.00%	3.7666 F.M.

COMBINED "B" MIX
(Sand, Limestone and Gravel)

Screen	% on	
¾	0	.00
⅜	5	.05
4	31	.36
8	7.5	.435
14	11	.545
28	18	.725
48	14	.865
100	11	.975
Thru 100	2.5	....
	100.0%	3.955 F.M.

UNIT WEIGHTS OF LOOSE AND DAMP MATERIAL

(1) Bkt. sand .....35 lb.
(1) Bkt. limestone .....30 lb.
(1) Bkt. gravel .....37½ lb.

(U. S. Standard 12-qt. bkt.)

MIX "A"
(Sand and Gravel)

Parts by vol. Loose & damp	Ingredient	Parts by vol. Dry rodded		Loose & damp Weight
(1) Bkt.	Cement	1.00	(Dry)	31 lb.
(5) Bkt.	Sand	3.75		175 lb.
(2) Bkt.	Gravel	2.00		75 lb.
(8) Bkt.		6.75		281 lb.

MIX "B"
(Sand, Limestone and Gravel)

Parts by vol. Loose & damp	Ingredient	Parts by vol. Dry rodded		Loose & damp Weight
(1) Bkt.	Cement	1.00	(Dry)	31 lb.
(3) Bkt.	Sand	2.25		105 lb.
(2) Bkt.	Limestone	1.50		60 lb.
(2) Bkt.	Gravel	2.00		75 lb.
(8) Bkt.		6.75		271 lb.

NOTE: Exactly 9 qt. of water used in each batch, moisture in aggregates not included.

slump on being removed from the machines, the higher the strength.

A very simple yet reliable comparative absorption test can be made as shown in Fig. 1. The No. 1 block is an all-sand block of a 1:6 mix, the No. 2 block was made up with 37½% of the sand replaced with pulverized limestone. About an inch of water was placed in the pan and the block stood on end. The result can be plainly seen. The rough appearance of the No. 2 block is due to the "web" marks produced by having an abundance of paste.

The absorption qualities of concrete units are a very important point in sales talks. Herewith is a copy of a test sheet showing the direct comparison between two different types of terra cotta tile and a concrete block, giving the average compressive strength and absorption of each. Comparative tests on competitive products as well as on brick and terra cotta tile are great helps in sales work.

There is given the results of a direct comparative test which was made exclusively for this article to show the benefit of a small portion of limestone in a fairly well designed mix of sand and gravel. The type unit used was the same as shown in Fig. 1, being a two-cell 8x8x16-in. unit. The area of 123.95 sq. in. as shown is the gross area, the net area being around 84 sq. in.

It might be well to state at this point that an ideal products mix should have a fineness modulus of between 3.75 and 4.25 and have at least 25% retained on the No. 4 sieve. The mix can be checked from time

(*Continued on page* 24)

Cement Bound Roads[1]

By W. P. ANDREWS
B.E., Assoc. M. Inst. C.E.

THE enormous evolution in road work caused by post war conditions has led to the introduction of many new forms of surfacing. Some of these have had a very brief existence, while others have steadily improved until a definite standard of excellence has been obtained.

The use of cement, both in foundations and surfacing, has been universal. The all concrete road is now a standard form of construction, especially for new work, and every year sees a large increase in the area laid—a sufficient proof of its popularity.

The cement bound road is a different proposition in that it is essentially a surfacing. It is a development of what was known some five years ago as cement grouted macadam, a form of construction that was successful or otherwise depending on the skill and interest of the labour employed, whereas the cement bound work can fail only through the use of wrong materials or deplorable weather conditions.

In the cement grouted method a four-inch coat of dry macadam was laid down and on it a dry matrix of sand and cement was spread and worked through the stones by brushing and rolling. Water was subsequently added and the whole rolled to consolidation. Optimism suggested that the mortar would get round the stones and form a binder. Actually this happened in patches but there was no security either that the penetration of the binder was uniform or that the distribution of the water was as hoped for.

Such roads, however, as were constructed by this method suggested great possibilities if the faults shown by earlier failures could be eliminated. To control the water content and to ensure uniform distribution of the binder were the elementary difficulties, the surmounting of which produced the sandwich method of construction known as the Cement Bound Road.

The process briefly consists of mixing the sand and cement as a mortar, sandwiching it between two layers of stones and consolidating with a roller. The water content is thus settled by the wetness of the mortar, while uniformity of penetration is ensured by the mortar working its way to the surface after it has filled the voids in the bottom layer of stones. Any bare patches in the surface are filled by brushing surplus mortar into them from other parts of the surface.

The cement bound road must not be confused either with the concrete road or with the cement grouted road. It differs from the former in that it is essentially a surfacing and as such requires a reasonably good foundation. It differs from the latter in the method of construction and in the results obtained. Perhaps it is best regarded as an adaption of the old water bound road in which the mud filler is replaced by a strong binder of cement mortar which prevents internal attrition and surface disintegration.

The surface of the cement bound road can be varied to suit different conditions. For a level road its appearance resembles that of a concrete road with the stones appearing as a mosaic. For the gradients the stones are left a little "proud" of the surface by sweeping the matrix while it is still soft out of the joints. The steepness of the gradient determines the degree of roughness required and this roughness is obtained by judicious sweeping. This roughness is of an ordered appearance differing from cobble paving in that smooth riding is still maintained, different from other surfacings in that every inch of the surface gives a foothold for horses and skidding is impossible, and differing from water bound macadam in that it is impervious to all scouring effects, subsurface attrition and surface erosion.

The difficulty of catering alike for motors and horse traffic is one of the greatest confronting highway engineers, and the cement bound road undoubtedly is the nearest approach to the ideal.

It is rather remarkable that this road has found most favour in Ireland, a country where the horse has to be catered for as much as the motor. In rural districts there the horse still has precedence and it is in such districts that the longest stretches of cement bound work are to be found and that this road has attained most uniform popularity.

In Great Britain the past year has seen the birth of a new interest in the work, especially for roads on gradients catering for mixed traffic. Such authorities

[1] Reprinted from November, 1930 issue of *Good Roads*, a magazine published in England.

as Cumberland C. C., Blackburn C. B., Whitehaven M. C., Dalton-in-Furness U. D. C., and Burnley R. D. C., have earned the blessings of horse owners for providing them with roads on which their horses have got an excellent foothold even during severe frost and which have given the minimum tractive resistance to their vehicles, while motorists tired of the failures and bumpiness of old roads have equally welcomed the innovation.

The question of cost inevitably springs to one's mind. Without going into great detail the initial cost may be said to average in Great Britain about 4/-to 4/6 per super yard. The governing factor is the local prices of stone, sand and cement and without a knowleldge of these a definite estimate cannot be made. Compared with water bound macadam the cost of construction averages 1/- to 1/3 per super yard more where the same aggregate is used but this shilling is saved many times over in the life of the road and absence of maintenance costs.

The work has been done as cheap as 2/4 per super yard in Ireland and 2/6 in England (at Keswick) but these figures cannot be taken as other than records.

The life of the road is a prime consideration with cost, and on this point no definite data is available. The cement bound road was first tried out in 1926, since when several improvements in the method have been evolved. Some roads down three and four years are today as good as new and look like being good for several more years. Maintenance on them in the meantime has been literally nil, even tar spraying not being required. Buxton Hill, Ashbourne, Derbyshire, may be quoted as an example. The gradient here is 1 in 7, the horse and motor traffic well balanced, and the surface after 3½ years shows no signs of deterioration, while the maintenance costs have been as stated.

Quite a different consideration of the cement bound road is that it provides a market for British Stone, sand and cement and employment for local unskilled labour.

In an article in "Cement Lime & Gravel" of June, 1930, Mr. A. Watson, Legat, M.Inst. C.E., pointed to the fact that producers of stone and sand had a greater financial interest in a cubic yard of concrete than had the cement manufacturers and that in this cubic yard there was approximately 13/- worth of stone, 6/- worth of sand and 13/- worth of cement. This argument applies even more strongly in the case of the cement bound road. Analysis of the cost of 200 super yards of such a road has shown that stone and sand represented 40 per cent of the expenditure, cement 25 per cent, the remaining 35 per cent going to labour, plant and incidentals. The materials used were 23 cubic yards of stone, 7 cubic yards of sand and 3½ tons of cement.

It may here be mentioned that the aggregate used is all 2 ins. cubical macadam anything under 1½ ins. being eliminated. Naturally, a good wearing stone is required since the stone takes all the traffic abrasion, the cement and sand being merely a binder, and any additional expenditure incurred by going some distance for a suitable stone will be well repaid by the increased life of the road.

The sand must be good quality suitable for concrete work. Granite dust has proved very satisfactory and has been used at Penrith, Keswick and other places this year. Other stone dusts must, however, be regarded with suspicion and should be tested before use.

The cement should be of the highest quality and rapid hardening. The ratio of cement to other aggregates is very low and this makes it desirable that the hardening out process should be as rapid as possible. Ferrocrete cement has been almost universally used for the work and has proved most valuable.

No skilled labour or expensive and elaborate plant is required. A good foreman and a capable spreader will assist enormously. The plant needed is practically identical with that used in waterbound work, with the addition of concrete mixing facilities. The rate of progress with a gang of 11 men and good organization is 300 to 350 super yards per day.

The fact that cement bound work can be carried out in any weather except severe frost or very heavy rain is another advantage which will be appreciated by surveyors who have seen work held up for indefinite periods waiting for good weather. A fine rain is more beneficial than otherwise to the road as it helps the curing of the concrete and thereby adds to its strength.

Due to some failures which occurred in the old cement grouted road, with which the present system is only too often confused, there has been a prejudice against it however. That the success of the sandwich method is killing the prejudice is undoubted. Two years ago the cement bound road was unknown in Lancashire. Last year saw five roads done. This year the number promises to be at least twenty. In Cumberland eight such roads have been done this year, one at Keswick probably the steepest yet attempted, being on a gradient of 1 in 4.

(*Continued on page* 22)

The Crushed Stone Journal

Official Monthly Publication of the
NATIONAL CRUSHED STONE ASSOCIATION, INC.
Merchandise Building 1735 Fourteenth St., N. W.
WASHINGTON, D. C.

J. R. BOYD, Editor

Officers and Executive Committee — National Crushed Stone Association

OFFICERS

W. F. WISE, President
Southwest Stone Co., Dallas, Texas

F. T. GUCKER, Treasurer
John T. Dyer Quarry Co., Norristown, Pa.

J. R. BOYD, Secretary
Washington, D. C.

A. T. GOLDBECK, Director, Bureau of Engineering
Washington, D. C.

REGIONAL VICE-PRESIDENTS

C. M. Doolittle (Canadian) — Allen Patterson (Central)
Paul C. Graham (Western) — W. R. Sanborn (Northern)
Harry Landa (Southwestern) — T. I. Weston (Southern)
A. S. Lane (Eastern) — Porter W. Yett (Northwestern)

EXECUTIVE COMMITTEE

W. F. WISE, Chairman
W. M. Andrews — O. M. Graves
H. E. Bair — E. J. Krause
C. M. Doolittle — A. L. Worthen

Meet Me At The Hotel Jefferson

NO MATTER to whom such a remark may be addressed, providing he is in any way identified with the crushed stone industry of the United States or Canada, it is reasonably certain that he will literally meet him at the Jefferson Hotel, St. Louis, Missouri, on January 19 to 22. It is both timely and appropriate that all whose interests identify them with our industry should meet with one another on the occasion of the Fourteenth Annual Convention of the National Crushed Stone Association. This meeting presents to crushed stone producers the only opportunity throughout the year for them to meet with one another in open forum to discuss common problems, exchange experiences and hear subjects of vital and direct interest presented by speakers outstanding in their respective fields and who have a sympathetic understanding of the many baffling problems which perplex us, and for which we are earnestly and conscientiously seeking a solution. The Association's annual convention is in every sense of the term a business meeting, relieved to be sure with a background of unique and diversified entertainment, but primarily an opportunity to give serious and thoughtful attention to the problems of the industry. No particular plea is necessary to those who have formed a habit of attending these annual foregatherings but to him who has not yet experienced the many benefits and pleasures to be derived from attendance at our annual convention we most sincerely and cordially invite him to be with us in St. Louis, nor is this invitation restricted only to those who are members of the National Crushed Stone Association but is meant to include all who are interested, directly or indirectly in the crushed stone industry.

The Washington Office has for weeks been a beehive of activity in preparation for our sojourn on the banks of the Mississippi, to say nothing of the indefatigable efforts which have been put forth by the Entertainment Committee headed by E. J. Krause, who has devoted himself most enthusiastically to the task of seeing that all who come to St. Louis will long remember the gracious courtesy and sincere hospitality with which they were received.

The ladies who attend will be most delightfully entertained from the time of their arrival until their departure. We are permitted to say that a distinct surprise is in store for them but have been bound to secrecy regarding its exact nature. The sightseeing trip arranged for Tuesday with luncheon at the Art Museum should be particularly interesting when it is realized that Emily Grant Hutchings, art critic and author, will personally conduct this tour. By all means bring the ladies for they are to be entertained as never before.

The Manufacturers' Division Exposition will be even larger and more diversified than in past years and it is most gratifying to be able to announce at this writing that all of the exhibit booths provided for will be occupied, the last available booth having been taken but a few days ago. A particular effort has been made this year to allow more time for an inspection of the exposition, it being realized that the members of our Manufacturers' Division spare no efforts in either time or expense in displaying for our information the latest developments in quarry equipment, machinery and supplies. Monday evening has been turned over exclusively to the Exposition. In the past it will be remembered that after the formal opening

of the Exposition, it has been customary to hold a Smoker. In view of the fact that elaborate arrangements have been made by the St. Louis Group to entertain the delegates to the Convention on Tuesday evening it was decided to dispense with the Monday evening entertainment and thus permit all those who desired, to fully and completely inspect the exhibits. This feature of the Convention will be formally opened at 7:30 P. M. on Monday evening and it will remain open until a late hour. A group luncheon for Operating Men, Superintendents and Manufacturers will also be held on Tuesday and as the afternoon group meetings on that day will consist of one for salesmen and one for those interested in agricultural limestone, the superintendents and operating men are given an additional opportunity to inspect the Exposition. As a further effort to encourage everyone present at the Convention to view each and every exhibit, the prize contest which was received with such popular favor last year will be repeated again at St. Louis. It will be remembered that those successfully completing the contest card enjoyed the privilege of drawing with the other successful contestants for ten beautiful and appropriate prizes. Included among these prizes this year will be an artistic cocktail set consisting of shaker and six pewter goblets, a large silver flask, smoker's set consisting of humidor and lighter, an ostrich leather wallet and many other useful prizes.

Two years ago the Manufacturers' Division voted to limit its membership to one hundred firms and it is particularly pleasing to announce that the quota has now been filled and that subsequent applications for associate membership will be filed in the order in which they are received and new members taken in only as resignations take place. To accomplish this result has required tireless efforts on the part of the members of the Manufacturers' Division and is but one more indication of their earnest and sincere desire to assist and cooperate with us in every possible way. We wish to gratefully acknowledge our appreciation and express the hope that the Division's membership can be maintained at one hundred throughout the coming year.

At the Cincinnati Convention held last January it will be recalled that Thursday was devoted to a Trade Practice Conference for the entire crushed stone industry and consequently the convention concluded with the banquet held Wednesday night. In contrast to this the St. Louis Convention will not be concluded until the Farewell Luncheon held on Thursday at one o'clock. The program Thursday morning is an unusually attractive one and all who are planning to attend should by no means leave until after the conclusion of this session. It will open with a brief report from the Committee on Accident Prevention presented by A. L. Worthen, Chairman. Following Mr. Worthen, T. J. Quigley, Chief, Mines and Quarries Section, Department of Labor and Industry, Pennsylvania, will speak on the subject of "The Control of Accidents." His topic is most timely and in view of his extensive experience gained from his accident prevention work with the State of Pennsylvania his contribution will prove especially interesting and valuable. One of the most important developments in the highway field during the coming year will be the secondary road problem and Charles M. Upham, Engineer-Director of the American Road Builders' Association will give us his views on this question. Following Mr. Upham, Dr. H. S. Hulbert, Psychiatrist of Chicago, Ill., will speak on the subject, "Mental Self Discipline Aids in Industry." It was our pleasure to hear Dr. Hulbert address the Quarry Section at the last annual meeting of the National Safety Council held in Pittsburgh and his remarks were exceptionally interesting and instructive. We are fortunate indeed to have obtained him as a speaker for our St. Louis convention and all executives and superintendents should make it a point to hear his discussion.

Those in charge of the various arrangements and details for the St. Louis Convention are doing everything possible to assure its success. This effort is being put forth in order that you may have an enjoyable and profitable contact with others engaged in the production of crushed stone and thus be better equipped to carry on during 1931. Obviously the final factor in the success of the Convention is your presence at St. Louis and we earnestly suggest, if you have not already done so, that you immediately make reservations by communicating direct with the Hotel Jefferson, St. Louis, Mo. And in conclusion let us express the hope that we all will meet at the Hotel Jefferson on January 19 to 22.

TO OBTAIN the benefits of reduced railroad rates to the St. Louis Convention, it is essential that you present to your ticket agent when purchasing transportation a round trip identification certificate which will permit you to buy a round trip ticket on the basis of fare and one-half. If you have not already received the necessary certificates to meet your requirements, write or preferably wire the Washington Office immediately.

Organization of Texas Crushed Stone, Sand and Gravel Association Completed

By W. W. CARSON, JR.,
Executive Engineer

"TO PROMOTE and extend the use of the products of the industry; to provide an organization for the cooperation of its members and the co-ordination of their efforts in all matters pertaining to the industry; to establish and maintain business practices of the highest standard." With the foregoing quotation from its constitution as a declaration of purposes, the Texas Crushed Stone, Sand and Gravel Association was formally launched at a final organization meeting held in Austin, Texas, Saturday, November 29, 1930.

Officers of the new association are as follows:

President, W. E. Sampson, Texas Construction Materials Co., Houston, formerly president, Texas Sand and Gravel Producers Association.

Vice-President, E. Eikel, Dittlinger Lime Company, New Braunfels, formerly president, Southwestern Division of the National Crushed Stone Association.

Secretary-Treasurer, W. A. Wansley, W. D. Haden Company, Houston and Galveston, formerly Secretary-Treasurer, Texas Sand and Gravel Producers Association.

The above named officers, together with the members listed below form the Board of Directors:

Max Altgelt, New Braunfels Limestone Co., New Braunfels, Texas.

R. J. Hill, Gifford-Hill & Co., Dallas, Texas.

J. P. Lively, Jacksboro Stone Products Co., Jacksboro, Texas.

T. E. Popplewell, Ft. Worth Sand & Gravel Co., Ft. Worth, Texas.

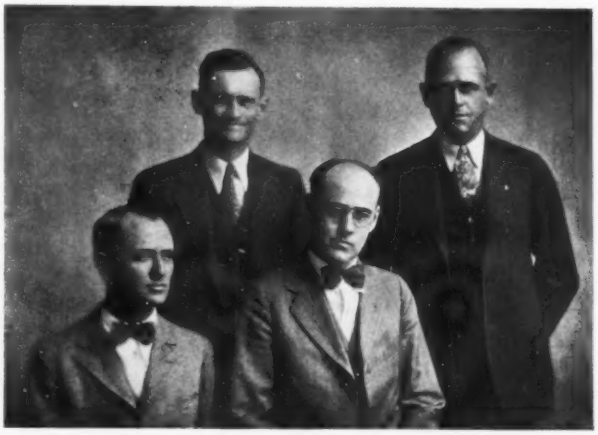
W. W. Carson, Jr., of Austin, was elected Executive-Engineer by the Board of Directors.

The newly perfected organization marks the consummation of plans under consideration for several months for consolidating the Southwest Crushed Stone Association and the Texas Sand and Gravel Producers Association. The entire membership of the two existing associations, so far as canvassed, went into the new organization, and all the assets, records and data of the two associations were turned over to the new Board of Directors. Necessary incorporation was had by a properly revised charter filed with the Secretary of State of Texas.

The Southwestern Division of the National Crushed Stone Association was organized in April, 1926. Mr. R. J. Hank, formerly State Highway Engineer of Texas, acted as Executive-Secretary for several years, resigning several months ago to again accept a position with that Department. The Association was well officered and successfully carried on such activities as properly belonged to it.

The Texas Sand & Gravel Producers Association was organized August 1, 1927, duly incorporated under the laws of the State of Texas. In addition to the routine work incident to such an association, it has successfully established a credit bureau and a uniform sales contract and discount policy.

At several times in the past, the two associations have found it necessary to create joint committees for handling important problems common to the entire industry. A notable example was the Southwest Freight Rate case under the so-called Hoch-Smith Resolution of Congress. Another was the proposed taxation of natural resources, and finally during the past year,



Standing left to right: E. Eikel, W. A. Wansley; seated left to right: W. W. Carson, Jr., W. E. Sampson

the complete revision of aggregate specifications by the State Highway Department of Texas. It gradually became quite obvious to the membership of each association that their problems are nearly all common to both industries—in fact that there is really only one industry instead of two. Furthermore some companies are producing both materials. They saw that the troubles of the stone man differed little from the troubles of the gravel man—no more than the troubles at two gravel plants, or two stone plants, may differ from each other. They also recognized that many questions can be handled only by united action. Having reached these conclusions, considerations of efficiency and economy plainly dictated the consolidation, and it was perfected with entire harmony throughout the whole group.

The Texas Crushed Stone, Sand and Gravel Association maintains permanent headquarters at 601-603 Littlefield Building, Austin, Texas. There are a few producers eligible for membership not represented at the organization meeting who will no doubt come in. When the canvass is completed it is believed that all producers of any considerable size will become active members, thus embracing the entire membership of both the old associations.

The present membership, which represents about 97,000 tons daily capacity, is as follows:

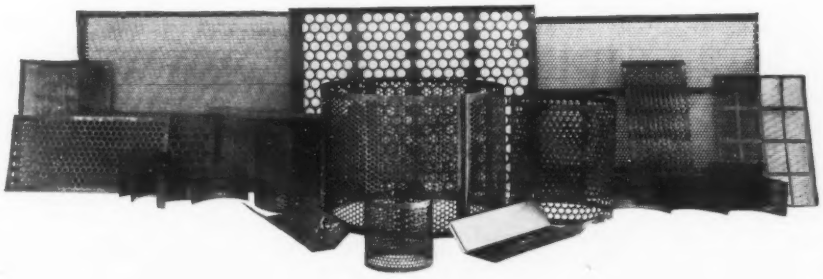
Dallas Washed & Screened Gravel Company, Dallas, Texas
Dittlinger Limestone Company, New Braunfels, Texas
East Texas Sand and Gravel Co., Dallas, Texas
Fort Worth Sand and Gravel Co., Forth Worth, Texas
Gifford-Hill & Company, Inc., Dallas, Texas
W. D. Haden Company, Galveston, Texas
Hillsdale Gravel Company, Sweetwater, Texas
Horton & Horton, Houston, Texas
Geo. R. Humlong & Sons, San Angelo, Texas
Jacksboro Stone Products Co., Jacksboro, Texas
Midland Sand & Gravel Co., Terrell, Texas
Moore & Moore Sand & Gravel Company, Chillicothe, Texas
New Braunfels Limestone Company, New Braunfels, Texas
Potts-Moore Gravel Company, Waco, Texas
Saxet Sand & Gravel Company, Houston, Texas
Southwest Stone Company, Dallas, Texas
Texas Construction Material Co., Houston, Texas
Texas Sand & Gravel Co., Waco, Texas
Urbana Sand & Gravel Co., Urbana, Texas
Western Sand & Gravel Company, Amarillo, Texas

PERFORATED METAL SCREENS

The quality of CROSS Screens gives longer service, increased production and lower cost.

CATALOG ON REQUEST.

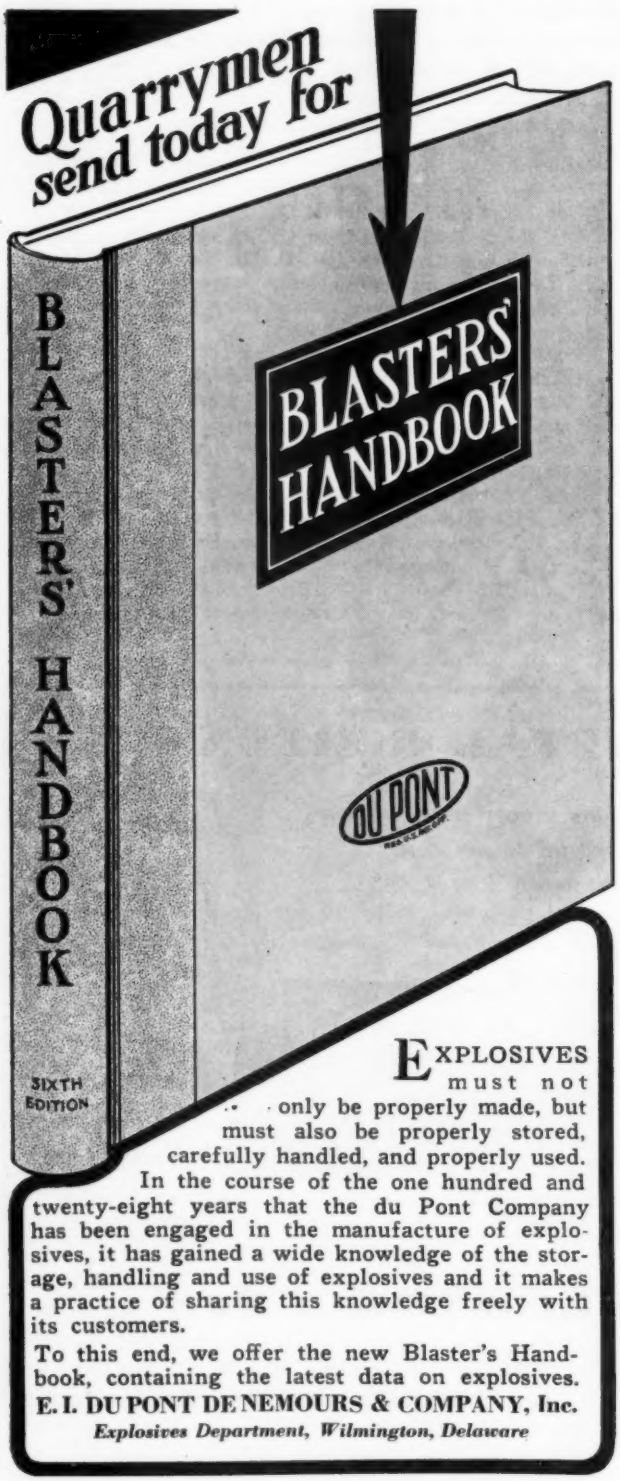
BUCKETS, TROUGH, FLIGHTS, CHUTES, ETC.



Rush Orders often Shipped within twenty-four hours

CROSS ENGINEERING CO.

CARBONDALE, PA.



EXPLOSIVES must not only be properly made, but must also be properly stored, carefully handled, and properly used. In the course of the one hundred and twenty-eight years that the du Pont Company has been engaged in the manufacture of explosives, it has gained a wide knowledge of the storage, handling and use of explosives and it makes a practice of sharing this knowledge freely with its customers.

To this end, we offer the new Blaster's Handbook, containing the latest data on explosives.

E. I. DU PONT DE NEMOURS & COMPANY, Inc.

Explosives Department, Wilmington, Delaware

Increased Federal Aid Funds Help Unemployment

INCREASED appropriations by Congress for cooperative construction of highways in the Federal-aid system for 1931 had an immediate effect upon unemployment with the result that in August the Federal-aid road program alone provided employment for 48,000 men, Thos. H. MacDonald, chief of the Bureau of Public Roads, stated in the annual report of the Bureau, just made public by the Department of Agriculture.

The Federal increase in appropriations for 1931 from $75,000,000 to $125,000,000 brought about State increases from $70,428,896 to $102,498,084, according to the report.

During the fiscal year, ending June 30, the 48 States and Hawaii, in cooperation with the Federal Government, completed improvements on 9,349 miles of highways, including bridges and their approaches, the report shows.

At the close of the year, 193,049 miles of interstate and intercounty highways were included in the Federal-aid system, and of this number, 84,012 miles had been improved with the aid of Federal funds, the report discloses. The Bureau completed improvements on 266 miles of forest roads and 88 miles of roads in national parks.

The type of surfacing required on various highways was ascertained by the Bureau by obtaining in each geographic area an appropriate index of the general density of traffic. The density was learned by taking the number of registered motor vehicles per mile of Federal-aid system, according to the report.

Depending on the density of the traffic, three types of surfacing, high, intermediate and low, were used in improving roads. In its tests, the Bureau ascertained that the traffic density in the Middle Atlantic States was 395 motor vehicles per Federal-aid mile, while in the New England and east north-central States it was 268 and 230 motor vehicles per Federal-aid mile, respectively.

The total length of Federal-aid bridges and bridge approaches at the end of the year was 332 miles.

A traffic survey, a study of soils to determine their respective qualities for road constructions, experiments on types of low-cost surface, studies to determine the characteristics of concrete as paving, and an analysis of possibilities of greater economy in road construction also were completed by the Bureau last year, the report states.

President's Emergency Committee for Employment Urges Increased Road Construction

LEGISLATION to permit grants of Federal funds to States for the construction of secondary roads, and Federal loans to States with which to match the Federal funds granted, are favored by the President's Emergency Committee for Employment, according to oral Statements December 4 by the Chairman of the Committee, Col. Arthur Woods, and Frederick C. Croxton, regional director for the Committee in the central northern States. These grants of funds, Mr. Croxton explained, would be in addition to the grants authorized by present law, which apply only to main roads.

Legislation to eliminate "red tape" in getting public construction projects actually started will be presented to Congress by Senators Smoot (Rep.), of Utah, and Keyes (Rep.), of New Hampshire, as a result of conferences of the Senators with Col. Woods, the Attorney General, William D. Mitchell, and Treasury Department officials, Col. Woods stated.

Establishment of 10 or 12 committees under the Treasury Department to act in various parts of the country in selecting sites for public buildings, instead of the single organization used at present, is one step in elimination of delays which the Committee will seek through legislation, Col. Woods said. These committees would operate only for the duration of the employment emergency, he said, and would speed up the projects by reducing the time consumed in selecting sites for buildings.

Would Employ Outside Architects

A second proposal will be to permit the employment of other than Federal architects to draw up specifications for projects, Col. Woods continued. Under present law, outside architects may draw up plans for the projects, but not specifications, and it is expected that the change will expedite the work.

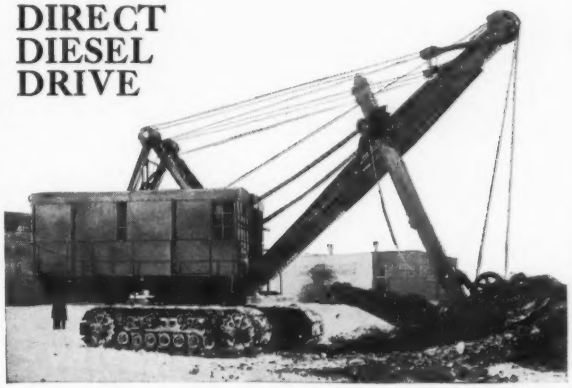
A third plan is to permit cities to own their own post offices where the business of the post office is more than $5,000 a year, instead of $7,500 as at present, according to Col. Woods. He believes such a procedure would result in additional construction, he said.

The extension of road construction to secondary roads is the only method found for extending employment to areas remote from the cities, Mr. Croxton said. He declared the proposal would require Federal legislation, and in many cases State legislation also.

Types

800 (2 - 2½ CU. YDS.) and 900 (3 - 3½ CU.YDS.)

with DIRECT DIESEL DRIVE



Direct Diesel drive has made a distinct impression upon engineers and others responsible for loading costs.

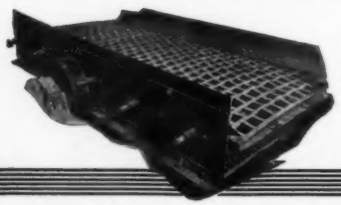
Power is applied *directly* to the hoisting, traveling, crowding, and swinging mechanisms. No complicated electrical generators and motors are interposed between the engine and the parts that do the work. This direct, simplified drive insures maximum delivery of power to the digging end.

There are many other advantages of Diesel drives. Only a small volume of low-cost fuel is required. The engine torque actually increases when the machine is slowed down below 50% of normal speed in heavy digging. Combined, these things insure low-cost yardage.

A new conception of shovel economy awaits you. Ask for Bulletin describing P & H Types 800 and 900 Diesel Shovels fully.

HARNISCHFEGER CORPORATION
Established in 1884
4425 W. National Avenue, Milwaukee, Wisconsin
Offices and Agents in All Principal Cities
WAREHOUSES AND SERVICE STATIONS
Hoboken, Memphis, Jacksonville, San Francisco, Los Angeles Seattle, Dallas

P&H Diesel EXCAVATORS



A Vibrating Screen ... is a *Better* Screen with *Corrugated* Plate

USING corrugated punched plate on vibrating screens is by no means an unknown practice.

It has been tried out in several plants, found successful and continued.

Try this type of screening medium on your vibrating screen. Hendrick can supply you with the proper plate.

HENDRICK MFG. CO.

39 River St., Carbondale, Pa.

BALTIMORE BIRMINGHAM BOSTON CINCINNATI
CLEVELAND DETROIT HAZLETON NEW YORK
PHILADELPHIA PITTSBURGH

Makers of Mitco Interlocked Steel Grating, Mitco Shur-Site Treads, Mitco Armorgids and Elevator Buckets of all types.

New Stephens-Adamson Catalogs

TWO new catalogs featuring conveying, screening and washing equipment, one for sand and gravel and the other for stone crushing plants, have just been published by Stephens-Adamson Mfg. Co. of Aurora, Ill.

Each book contains about 75 pages and specializes in recent developments in plant arrangements and units for handling and producing material. Typical layouts are shown for plants of different sizes and processes, ranging all the way from the simple dry screening plant up to the large crushing, screening and washing plants equipped for storing, reclaiming and loading as high as two or three thousand tons an hour.

A section in each book contains an interesting description of the self-unloading freight boats that have been instrumental in decreasing the cost of delivering stone and gravel by water.

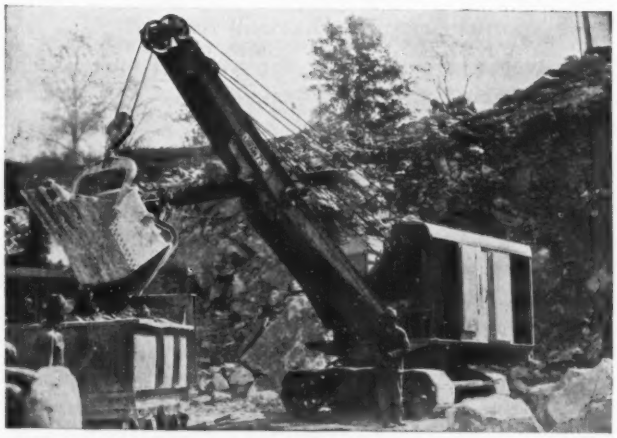
Emphasis has also been placed on the preliminary survey so necessary before a truly successful plant can be built. This includes a consideration of the deposit, market requirements, future tendencies, extent of the market, economical preparation and delivery.

Copies are being mailed out on request to the Stephens-Adamson Catalog Department.

THEW LORAIN 75

THEW CENTER DRIVE

HEAVY-DUTY QUARRY SHOVEL

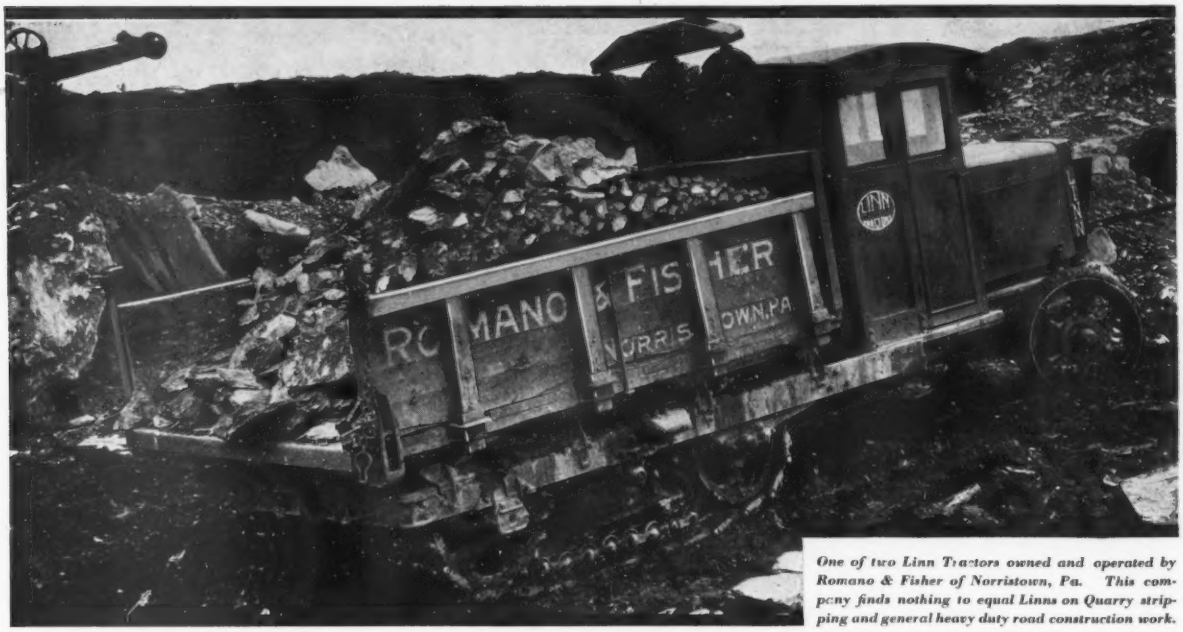


THEW SHOVEL COMPANY • Lorain, Ohio

¾ to 1¼ and 1½ yd. Shovels, Clamshells, Draglines

Electric, Gas, Diesel Powered

CERTIFIED PERFORMANCE SURVEY LT-53-HZ, MADE BY INDEPENDENT COST ENGINEERS



One of two Linn Tractors owned and operated by Romano & Fisher of Norristown, Pa. This company finds nothing to equal Linns on Quarry stripping and general heavy duty road construction work.

LINN WINS 2 TO 1 ON TOUGH QUARRY STRIPPING JOB

Only The LINN Offers You All These Advantages:

1. **Patented Flexible Traction that grips any surface under all weather conditions.**
2. **Tremendous hauling power---100 horsepower to take full advantage of LINN Traction.**
3. **Ten ton capacity on its own chassis.**
4. **Extra traction and power for additional tow loads.**
5. **Easy on men---steers like a truck.**
6. **Four speeds forward with four speed reverse optional.**

A. C. Nielsen Co., Independent Cost Engineers, find "Two Linns moving 400 yards daily . . . at cost of .147 per cubic yard even under severest weather conditions, and against grades ranging up to 30%."

Estimate of other equipment required to carry out this schedule was five 5-ton units indicating an average of 80 cubic yards, per day per unit.

Romano and Fisher, Contractors, find Linns invaluable on quarry stripping operations, because they lay their own road and carry full capacity, no matter how soft the ground.

Write for this convincing survey which furnishes many examples of Linn's all around capability in heavy duty hauling as well. Write for Survey LT-53-HZ.

LINN MANUFACTURING CORPORATION

LINN TRACTORS

Patent No. 1,270,531
Patent No. 1,521,454
Patent No. 1,685,641
Patent No. 1,685,676
Patent No. 1,701,979
Other Patents Pending

LA FRANCE REPUBLIC

Division of LaFRANCE-REPUBLIC Corporation

Factory: Morris, New York

Represented in:

New York City, Skowhegan, Maine, New Haven, Conn., Johnson City, Tenn., Pittsburgh, Louisville, Ky., Detroit, Chicago, St. Louis, Kansas City, Mo., Little Rock, Ark., Tulsa, Okla., Omaha, Nebr., Sioux Falls, S. D., St. Paul, Minn., Salt Lake City, Denver, Los Angeles, San Francisco, Portland, Ore., Spokane, Forty Fort, Pa.

Canadian Linn Distributors: Mussens Limited, Montreal



LONGER LASTING SCREENING

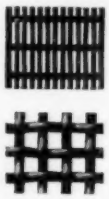
ROK-TEX

Woven for dependable service, every part that goes into the manufacture of "Buffalo" Wire ROK-TEX is planned to withstand all the hard knocks connected with stone screening. *Actual working tests have proved ROK-TEX has from 50% to 200% longer life than ordinary wire screening.*

Write for quotations, samples and full information

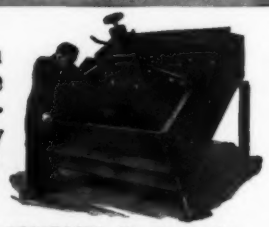
BUFFALO WIRE WORKS CO.
INCORPORATED
(Formerly Scheeler's Sons, Est. 1869)
585 Terrace Buffalo, N. Y.

HUM-MER *Electric* SCREEN



Screens from coarsest to the finest materials- either wet or dry

Catalogue sent upon request



The W. S. TYLER COMPANY - Cleveland Ohio.

WOVEN WIRE SCREEN

Relation Between Durability of Concrete and Durability of Aggregates

(*Continued from page* 9)

(This series should include tests on limestones from various localities and varying through a considerable range in quality as regards impurities which are apt to produce unsoundness).

2. Field studies.

Any field study to be of real value should be undertaken by a qualified investigator working under the guidance of an agency such as the Highway Research Board.

His duties would be to survey existing structures located in those sections where trouble from aggregates might be expected, obtain in each case a complete history insofar as possible of the installation, description of the failure, samples of the concrete and the aggregates, etc. He should also study structures which are still in good condition with the idea of obtaining information which will indicate conditions under which the same aggregates are giving satisfactory service.

In order to avoid duplication of effort any field survey such as that indicated above should be preceded by a thorough study of available information obtained as the result of surveys by other agencies, such as the American Concrete Institute and the Portland Cement Association.

Cement Bound Roads

(*Continued from page* 13)

In conclusion it is necessary to emphasize that reasonable care must be taken in the execution of the work. The use of dirty sand and aggregate, the over rolling after the cement has got its initial set, and the allowing of traffic on the road before it has hardened are samples of the causes of failure, all of which are very easily preventable.

In a booklet which they publish on cement bound roads the British Portland Cement Assn., Ltd., deal fully with the method of constructing the road and it has not been considered necessary to deal with this matter in detail here.

The writer's object has been rather to show that in cement bound work one obtains a road with a long life, which is simple and cheap to construct, costs little or nothing to maintain, which employs British labour and consumes British materials exclusively and a road which for mixed traffic even on the steepest gradient can justly claim to be "nulli secundus."

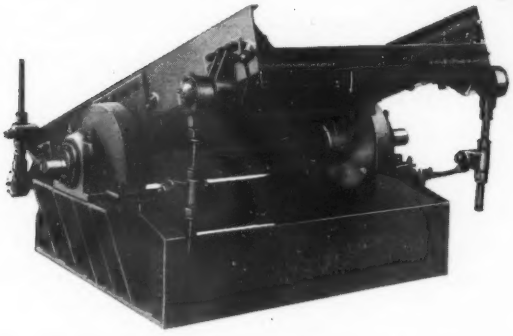
Built to Operate 24 Hours a Day



Be sure to see the Huron Exhibit at the Crushed Stone and Sand & Gravel Shows, St. Louis, in January.

HURON

HEAVIDUTY SCREENS



The outstanding success of these screens is due to their ability to perform continuously and to produce extra large tonnages of accurately graded material. They are especially designed and built to provide:

(1) Continuous 24-hour operation, with maintenance reduced to a minimum.

(2) Maximum output of accurately graded materials ranging in size up to 4 inches.

(3) Maximum length of service, even under the most adverse conditions encountered in crushed stone, gravel, coke, slag, mining and similar plants.

(4) Adaptability to meet various operating requirements, such as character and flow of material, washing of product, changes in sizing, plant layout, etc.

These results are accomplished by developments in design which are the outcome of over two years of extensive tests and use under actual working conditions.

You can solve your screening problems by installation of Huron **Heaviduty** Screens. Complete information on request. Ask for Folder 300.

Engineered to Meet Your Operating Requirements

If you are grading or scalping any kind of material up to 4 inches in size, you can obtain Huron **Heaviduty** Screens to exactly meet your operating conditions and give you maximum capacity and screening efficiency. There are three sizes of screen frames: 3' x 6', 4' x 8' and 5' x 10', with single, double and triple-deck models. Amount of eccentricity or "throw" can be made to suit the kind and size of material you are handling. Angle of screen frame and speed of operation can be readily adjusted.

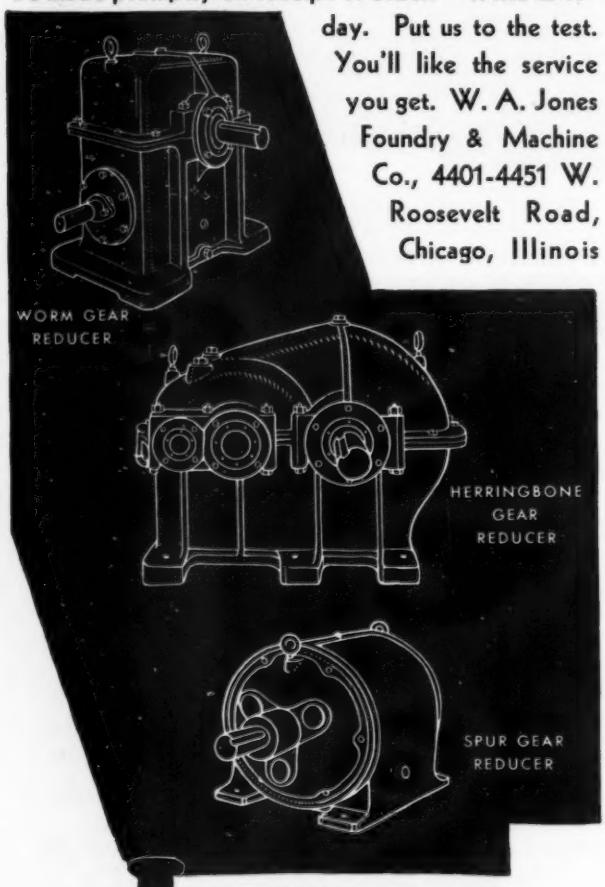
HURON INDUSTRIES, INC.

ALPENA, MICH.

Huron Industries, Inc., Alpena, Michigan.
Send me a copy of Folder 300.
Name.....
Company.....
City.....

Reducers you Need are Ready to Ship

All three types of Jones Speed Reducers—Herringbone, Spur and Worm—are carried in stock in a wide variety of standard ratios ready for quick shipment. No delay. Simply let us know what your speed reduction problem is. Our engineers will recommend the type and size of reducers most efficient and economical for your particular requirments. Deliveries will be made promptly on receipt of order. Write us today. Put us to the test. You'll like the service you get. W. A. Jones Foundry & Machine Co., 4401-4451 W. Roosevelt Road, Chicago, Illinois



Jones
HERRINGBONE—SPUR—WORM
REDUCERS

Limestone Screenings Improve Concrete Products

(*Continued from page* 11)

to time during the day by catching a quart cup of the mix as it comes to the machines and screening it in a bucket of water.

The screen analyses of the separate aggregate and the combined mixes are as below. While a number of different grades of limestone were available, this particular one was selected on account of having a minimum of fines, only 5% passing the 100-mesh sieve.

The effect of the limestone is more noticeable in leaner mixes and this ought to convince the most skeptical that even a good mix can be improved by the addition of limestone, although it does not contain a large amount of fine material.

Manufacturers of pre-cast tanks, vats, septic tanks, sewer pipe, etc., having to withstand hydrostatic tests, will find the addition of limestone very beneficial. It is also the author's opinion that it is only a question of time until nearly all architects and engineers will specify a portion of limestone in all mixes used for reinforced work, especially for basement walls, swimming pools, etc.

Increased Appropriations for Highways Sought in Bills

TWO bills designed to provide additional appropriations for highway construction work were introduced in the House December 1.

Representative Browne (Rep.), of Waupaca, Wisc., asked for an appropriation of $250,000,000 annually for the next two years for the improvement of highways.

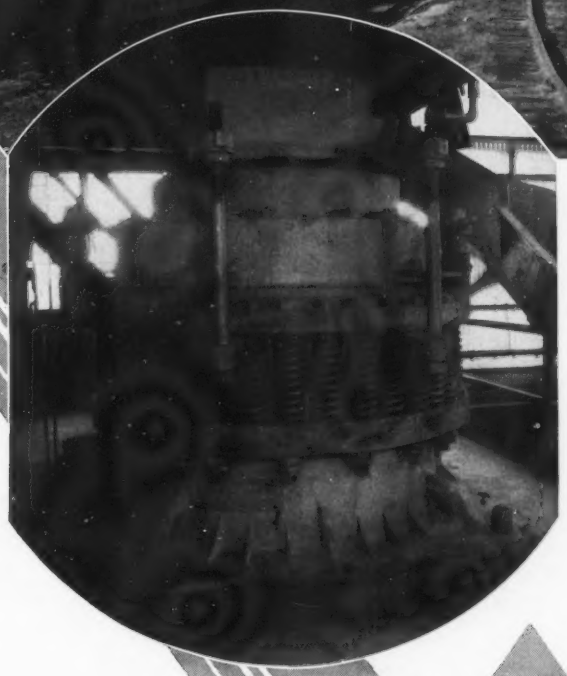
In another bill introduced by Representative Treadway (Rep.), of Stockbridge, Mass., it is proposed to liberalize the use of Federal funds for State aid in road construction.

Provisions of Bill

Mr. Browne's bill would provide that 50 per cent of the amount to be appropriated would be expended on trunk roads in the Federal highway system, and the other 50 per cent would be spent on rural roads. It is also proposed in this measure that the Federal Government would contribute at least 80 per cent and the States not more than 20 per cent of the cost of the highways constructed or improved with moneys appropriated under the act.

The proposal of Mr. Browne also would provide that the money appropriated would be aportioned among the States as the Federal aid is now apportioned. (Under the present law, one-third of the amount in proportion to the area of a State, one-third in proportion to the population, and one-third apportioned according to the number of miles of rural mail routes in each State).





The Crusher That the Leaders in the Industry Use

It is not surprising that the majority of the modern stone and gravel plants that produce a finely crushed product in quantity have installed Symons Cone Crushers. During the last few years, they have demonstrated their advantages and have won a host of admirers because of their unusual performance.

The changing conditions demand modern machinery. Perhaps your crushing operations may be hampered by obsolete equipment. If so, the answer will be found in the Symons Cone Crusher.

NORDBERG MFG. CO. MILWAUKEE, WISCONSIN

NEW YORK CITY
51 East 42nd St.

LONDON, W. C. 2
Bush House

LOS ANGELES, CALIF.
1462 Stanley Ave.

SYMONS CONE CRUSHER



"SPRING-STEEL"

Woven Wire Screens Wear Longer than Screens of Ordinary Steel

Many "SPRING-STEEL" screens are wearing twice as long as the same grades made of ordinary wire. MANY ARE WEARING SEVERAL TIMES AS LONG.

"SPRING-STEEL" saves the operating hours which screens of ordinary steel consume in frequent changes.

Yet "SPRING-STEEL" is inexpensive.

Visit our "SPRING-STEEL" exhibits in St. Louis.

Crushed Stone Show —January 19–22
Sand and Gravel Show—January 27–29

THE LUDLOW-SAYLOR WIRE CO.
ST. LOUIS, MO.

Shovel Dragline Crane

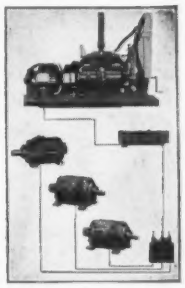


A COMPLETE range of shovel, dragline and crane equipment is ready to go with the Marion 1¼ yd. Gas-Electric — the new-type excavator that operates without clutches.

A SIZE FOR EVERY NEED

Type 450
1¼ yd. Steam, Electric, Gas-electric, Diesel-electric.
Type 32-1½ yd. Steam.
Type 460
1½ yd. Electric, Gas-Electric.
Type 480-2 yd. Steam, Electric.
Type 490-2¼ yd. Electric.
Type 4120-3 yd. Electric.
Type 5120-3 yd. Electric.
Type 4160-4 yd. Electric.
Type 125-4 yd. Steam, Electric.
Type 5320
8 yd. Steam, Electric.
Type 5480-12 yd. Electric.

Hundreds of these speedy, rugged machine are already in the field, outdigging and out-wearing clutch-type shovels in an amazing manner. In fact 50% of Gas-Electric owners operate *two or more* of this remarkable excavator. It is the only Gas-Electric in the field — Marion's exclusive contribution to the excavating industries. Type 450 will do *your* work. Write us about your own situation and the kind of equipment you need. Get the facts first hand without obligating yourself in any way.



Power is transmitted to three independent motors — no clutches to work and wear — and the engine can't be stalled.

Come to Shovel MARION *Headquarters*

THE MARION STEAM SHOVEL COMPANY

DISTRICT OFFICES — NEW YORK — CHICAGO — PHILADELPHIA — BIRMINGHAM
KANSAS CITY — SEATTLE — SAN FRANCISCO

MARION, OHIO, U. S. A.

» CHIPS «

THE AGE OF WOMEN

A young lady finding herself stranded in a small town, asked an old man at the station where she might spend the night.

"There ain't no hotel here," he replied, "but you can sleep with the station agent."

"Sir!" she exclaimed. "I'll have you know I'm a lady."

"That's all right," drawled the old man. "So is the station agent."—*Chips and Cuts.*

* * * * * * * * * *

A radio in a car is a wonderful thing. We were followed for several minutes by a motor cop the other evening and found out later he only wanted to hear Amos 'n' Andy.—*Judge.*

* * * * * * * * * *

There had been a motor accident. The driver climbed out angrily and up to a man whom he thought was the other driver. He said:

"Hey you! Where's your tail light?"

The innocent bystander looked at him with amazement and said:

"What do you think I am? A bloomin' lightning bug?"—*Exchange.*

* * * * * * * * * *

X is the Roman notation for ten;
X is the mark of illiterate men;
X is a ruler removed from his throne;
X is a quantity wholly unknown;
X may mean xenun, a furious gas;
X is a ray of a similar class;
X-mas is Christmas, a season of bliss;
X in a letter is good for one kiss;
X is for Xeres, that monarch renowned;
X marks the spot where the body was found.

—*Bruce Every Month*

A woman went into a chemist's shop and said: "Have you any Life Buoy?"

The assistant, a young American, replied: "Set the pace, lady."—*Tit-Bits* (London).

* * * * * * * * * *

Poor Bill—he was killed by a flask of lightning.

* * * * * * * * * *

Somebody asked a college professor how science helped business, and he replied, "What would the suspender business amount to without the law of gravitation?"

* * * * * * * * * *

HOW WARS BEGIN

A small boy asked his father how wars began.

"Well," said his father, "suppose that England quarreled with France—"

"But," interrupted the mother, "England mustn't quarrel with France!"

"I know," he answered, "but I am taking a hypothetical instance."

"You are misleading the child," said the mother.

"No, I am not," he answered.

"Yes, you are."

"No, I am not."

"Yes."

"No."

"All right, Dad," said the small boy, "I think I know how wars begin."—*Pullman News.*

* * * * * * * * * *

CAUGHT AGAIN

"How many fish was it you caught on Friday, Jack?" she asked.

"Six, dear," returned her husband. "And better fish you've never seen."

She looked at the bill in her hand.

"I thought so," she replied. "That fishmonger has made a mistake again. He's charged us for eight."

National Crushed Stone Association
Fourteenth Annual Convention

January 19, 20, 21 and 22, 1931
Hotel Jefferson
St. Louis, Missouri

●

Railroads Authorize Reduced Fares

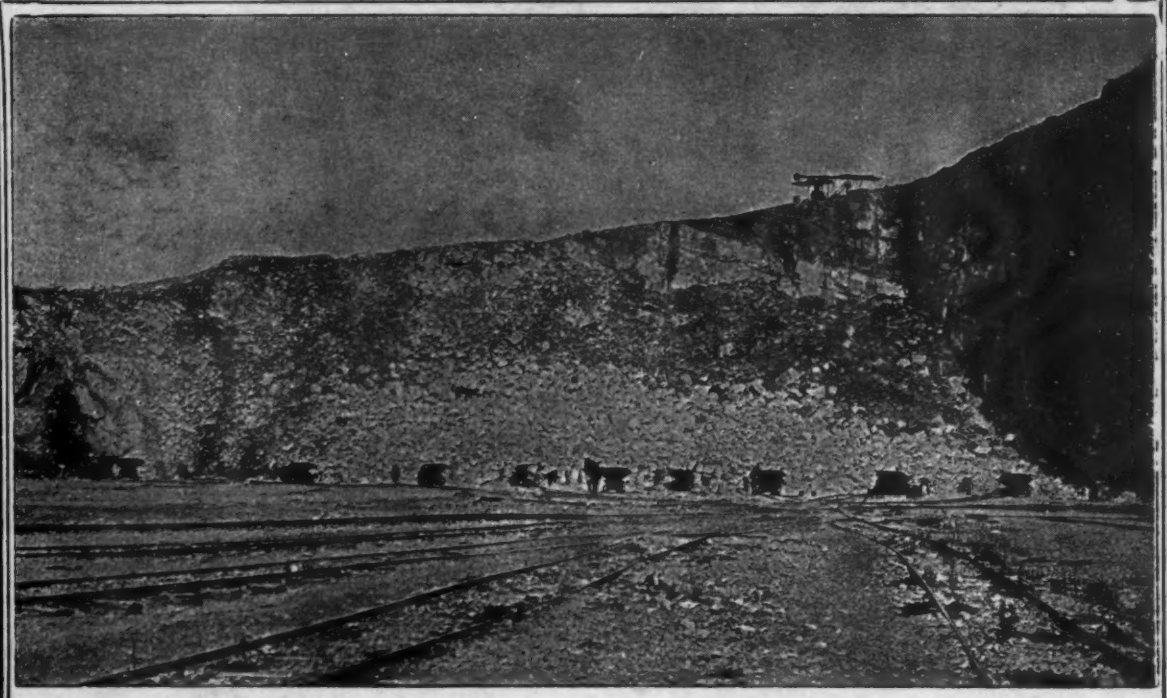
Important—Read Carefully

1. Reduced fare to St. Louis has been authorized under the Round Trip Identification Certificate Plan.
2. Upon presentation of certificate to ticket agent, delegate is entitled to purchase a round trip ticket to St. Louis for fare and one-half times the regular one way fare.
3. Certificates *will not* be available at offices of ticket agents, and can only be procured from the Secretary's Office in Washington.
4. Certificates are being mailed to all contemplating attendance at the Convention.

Have You Received Your Certificate?

If not, you should *immediately* communicate with J. R. Boyd, Secretary, National Crushed Stone Association, 1735 14th Street, N. W., Washington, D. C., requesting that one be sent to you.

5. Please help us to pass this information along as it would be regrettable if some of those attending the Convention were denied the privilege of obtaining reduced fare to St. Louis because they have failed to obtain a certificate.







CORDEAU Helps Improve the Fragmentation

CORDEAU, by speeding up the rate of detonation of the explosive charges in a blast, adds materially to the shattering effect of the explosive no matter whether it is a high grade dynamite or the slower blasting powders. Rock well broken, toe kicked out, little secondary blasting, and crushing units well supplied with rock mean good operating conditions and consequent profit for the quarry operator.

CORDEAU
DETONATING FUSE
BICKFORD

THE ENSIGN-BICKFORD CO.

SIMSBURY - CONNECTICUT